

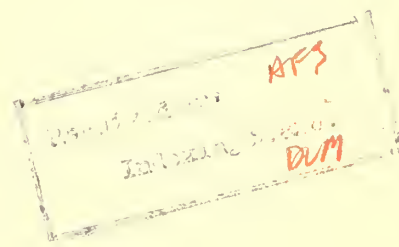
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Report of the
SIXTEENTH SOUTHERN PASTURE AND FORAGE CROP
IMPROVEMENT CONFERENCE

Mississippi State University
State College, Mississippi

June 9 - 11, 1959



Report of the
SIXTEENTH SOUTHERN PASTURE AND FORAGE CROP
IMPROVEMENT CONFERENCE^{1/}

Mississippi State University
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PROGRAM

Tuesday - June 9 - Morning

Page No.

10:00 A.M. Registration. Student Alumni Building.

Tuesday - June 9 - Afternoon Session

E. C. Holt, Texas, Presiding

1:30	P.M.	Opening Session.....	1
1:40	"	Welcome: Dr. Clay Lyle, Dean and Director.....	1
2:00	"	Introduction of Members.....	1
2:15	"	Present Status of Bloat Research - B. F. Barrentine, Mississippi.....	1
2:45	"	Business Session and Announcements.....	1
3:30	"	Laboratory Trip.....	2

Wednesday - June 10 - Morning Session

8:30	A.M.	Field Trip.....	2
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Wednesday - June 10 - Afternoon Session

Plant Breeding

J. R. Harlan, Oklahoma, Presiding

1:15	P.M.	<u>Methods of exploiting heterosis in forages -</u> Glenn W. Burton, Tifton, Georgia, Discussion Leader.....	2
2:15	P.M.	<u>Some approaches to breeding difficult to handle species -</u> Norman L. Taylor, Kentucky, Discussion Leader.....	3

^{1/} Reported by: J. R. Harlan, Oklahoma; E. M. Evans, Alabama; P. G. Hogg, Mississippi; and compiled by D. E. McCloud, Permanent Secretary, U. S. Department of Agriculture, Agricultural Research Service, Beltsville, Md.

3:05 P.M. Break

- 3:20 " A regional approach to a breeding program -
A. A. Hanson, Beltsville, Discussion Leader..... 5
- 4:15 " New development in forage breeding - Volunteers..... 13

Wednesday - June 10 - Afternoon
Plant Management - Animal Session
E. M. Evans, Alabama, Presiding

- 1:15 P.M. Panel Discussion - New Fundamental Research on Forage
Physiology and Microclimatology
D. E. McCloud, Beltsville
Panel Leader
- Sub-Cellular Physiology - S. H. West, Florida..... 13
Controlled Climate Chambers - E. G. Beinhart, Jr., S.C.... 14
Microclimate - C. Y. Ward, Virginia..... 14
Leaf Area Index - C. W. Alexander, Beltsville..... 15
- 2:15 P.M. Panel Discussion - Are Species of Animal, Age of Animal and
Season of Year Important Factors in De-
termining the Nutrient Qualities of
Forage? W. A. Hardison, Virginia
Panel Leader
- Sheep vs. Cattle - P. G. Woolfolk, Kentucky..... 17
The Rabbit as a Tester Animal - G. E. Hawkins, Ala..... 18
Young vs. Mature Animals - M. E. McCullough, Ga..... 19
Effect of Season of the Year - J. P. Fontenot, Va..... 21
- 3:30 P.M. Break
- 3:45 " Effect of Diet on Milk and Animal Fat - R. W. Engel, Va... 21
- 4:00 " Chemical Composition and the Digestibility of Forages -
H. L. Lucas, Jr., North Carolina and W. W. G. Smart, N.C.. 23
- 4:45 " General Discussion..... 27

8:15	A.M.	<u>Grass Pellets Versus Green Chop or Grazing -</u> Orien Brooks, Midville, Georgia.....	27
8:40	"	<u>Grass Pellets for Livestock Feeding -</u> W. B. Anthony, Alabama.....	28
		Discussion.....	28
9:45	"	Break	
		Topic - Pasture and Forage Utilization	
10:00	"	<u>Rotation Versus Continuous Grazing in the Humid Southeast -</u> Roy E. Blaser, Virginia.....	28
10:25	"	<u>Rotation Versus Continuous Grazing in Semi-Arid Southwest -</u> Marvin E. Riewe, Angleton, Texas.....	29
10:50	"	<u>Rotation Versus Continuous Grazing from the Dairyman's</u> Viewpoint - R. E. McCullough, Georgia.....	31
		Discussion.....	32
11:30	"	Business Meeting.....	32
12:00	Noon	Adjourn.	



Tuesday Afternoon, June 9, 1959

E. C. Holt, Conference Chairman

1:30 P.M. Chairman Holt called the conference to order and introduced Dr. C. Dale Hoover, Head of the Department of Agronomy, Mississippi State University. Dr. Hoover briefly stressed the importance of forages and in turn introduced Dean Clay Lyle who officially welcomed the conferees to the Mississippi State University.

2:00 P.M. Introduction of Members by States

Chairman Holt called upon one member from each state to introduce the delegates present.

2:15 P.M. Present Status of Bloat Research - B. F. Barrentine, Mississippi State University

Dr. Barrentine discussed briefly the five major kinds of bloat: (1) pasture, (2) feed lot, (3) toxic, (4) pathological, (5) obstruction. He reviewed the developments of the pasture bloat research project at Mississippi State University, as well as the present status of the S-39 regional bloat project. A field trip to the bloat research facilities was arranged for those interested in seeing the work underway.

2:45 P.M. Business Session and Announcements

Dr. E. N. Fergus, Kentucky, presented a committee report on forage evaluation. This committee is composed of: E. N. Fergus, Kentucky, H. L. Lucas, North Carolina, R. E. Blaser, Virginia, M. E. McCullough, Georgia and W. B. Anthony, Alabama. Dr. Lucas, North Carolina, re-emphasized the many facets of forage evaluation. He stated that forage value, to the grazing animal, equals the amount of forage consumed times the value per unit of forage. He stated that it is extremely difficult to predict from experimental plots the amount of forage which the grazing animal would consume. On the other hand, the value per unit, to the grazing animal, can be predicted with considerably more accuracy, perhaps with a 5 - 6 per cent tolerance. R. E. Blaser indicated the extreme difficulty in predicting the losses due to trampling as well as other grazing losses.

Committee Appointments

Chairman Holt appointed a nominating committee consisting of P. B. Gibson, South Carolina, R. D. Staten, Texas and G. B. Killinger, Florida. Also appointed was a resolutions committee consisting of W. W. Huffine, Oklahoma, and L. H. Taylor, Virginia.

Chairman Holt announced that the executive committee would consider invitations for the next annual meeting.

Announcements with respect to the field tour to the Seed Research Laboratory were made by Dr. H. W. Bennett. There being no more business at this time, the meeting adjourned.

3:30 P.M. Laboratory trip.

Wednesday June 10, 1959

8:30 - 11:30 A.M. Field Trip

The forage and pasture experimental work underway at Mississippi State University was observed in well-planned tours. Tours were made by buses supplied by the host institution. Included were stops to observe experimental pastures, the dairy research unit, grass breeding plots, turf research, the bloat research project and the new controlled environment growth room.

Wednesday June 10, 1959

Plant Breeding Session
J. R. Harlan, Oklahoma, Presiding

1:15 P.M. Methods of Exploiting Heterosis in Forages - Glenn W. Burton,
Tifton, Georgia

Hybrid vigor, a common phenomenon that occurs widely in economic crop species, is of sufficient magnitude to warrant commercial exploitation. Techniques to achieve this end may be divided into two broad groups depending upon whether the F_1 hybrid is propagated by asexual or sexual means. Usually, hybrid vigor can be most easily exploited in species that may be propagated asexually, either by vegetative means or by apomictic seeds. Coastal, Suwannee, Midland, and the turf Bermudagrasses furnish examples of F_1 hybrids propagated by vegetative means. Many named varieties such as Tucson side oats grama, King Ranch Bluestem, and Argentine Bahia carry hybrid vigor maintained by apomictic reproduction. Triploid and pentaploid Bahia hybrids reproduce by apomixis, but set little, if any, seed unless given a pollinator. Pensacola Bahia is an excellent pollinator for these hybrids.

The manner in which commercial F_1 seed is produced supplies a convenient basis for further classifying species that must be propagated by sexual means. Hand emasculation and pollination has long been used to produce hybrid seed of certain ornamentals and tomatoes. Hand emasculation is generally too expensive for low-value crops but the ease of making females by pulling the tassels from corn plants caused the hybrid seed-corn industry to use this method for many years. Cytoplasmic male sterility is currently being used to exploit heterosis in a number of crops including corn, sorghum, sugar beets, and onions. Cytoplasmic male sterility has been discovered in pearl millet and will, no doubt, be used for the production of pearl millet hybrids in the future. There is good reason to believe that cytoplasmic male sterility can eventually be found in most species.

Hybrid seed of dioecious plants may be produced by vegetatively plant-seed fields to alternate blocks of male and female plants. Mesa buffalograss seed will be produced in this manner.

Self-incompatability and vegetative planting are being combined to produce hybrid seed of Tifhi-1 Pensacola Bahia. Once seed fields are established, they can supply hybrid seed for many years with no expenditure of effort other than harvesting.

Gahi-1 pearl millet seed are being produced by harvesting all seed from fields planted to a mixture of equal numbers of pure live seeds of four inbred lines. Chance hybridization causes approximately 75% of such seed to be hybrids. When planted in the field at 10 pounds per acre in 36-inch rows, the more vigorous hybrid seedlings crowd out selfs and sibs, giving full hybrid performance. Hybrid vigor may also be exploited to some degree through the development of amphidiploids and synthetic varieties. Synthetics involving a number of lines cannot carry as much heterosis as the best singlecross and heterosis that may appear in the Syn 1 generation may be expected to decline with advancing generations.

2:15 P.M. Some Approaches to Breeding Difficult to Handle Species -

Norman L. Taylor, Kentucky, Discussion Leader

Jack R. Harlan, Oklahoma

Robert C. Buckner, Kentucky

Will A. Cope, North Carolina

J. P. Craigmiles, Georgia

Jack R. Harlan - Apomictic species are considered difficult to handle and it is especially frustrating to attempt to improve an obligate apomict. King Ranch Bluestem may be taken as an example. It is a pentaploid and highly if not obligately apomictic (like Dallisgrass?). We have obtained one hybrid with it, using it as a male on a facultative type. Perhaps a better approach would be to resynthesize a plant like KR from more desirable parents. Genomes from Bothriochloa intermedia and B. ischaemum are evidently involved in the constitution of K.R. The problem is in finding suitable parents with enough sexuality to make the appropriate crosses. So far we have produced: B. intermedia $4n$ X B. ischaemum $4n$ = $4n$ F_1 and B. intermedia $4n$ X B. ischaemum $6n$ = $7n$ F_1 . The first is vigorous, leafy, shows some heterosis, but is highly sterile. The second is vigorous, hardy, immune to rust, sets abundant seed by apomixis and looks rather promising. We have not yet succeeded in resynthesizing K.R., but we may improve on it anyway.

One difficulty in working with apomicts is a suitable source of sexuality. Several approaches are possible eg. (1) double a sexual diploid with colchicine to produce a sexual tetraploid -- this has been done on several occasions, (2) pollinate a large number of emasculated diploid flowers with a tetraploid -- if there is a tendency for unreduced eggs to be produced a sexual tetraploid may result. We have one plant produced in this fashion which is readily propagated vegetatively and is self-sterile, (3) Cross facultative types one with the other -- sexual types may be recovered. We have one plant derived in this manner, also self-sterile.

While these sexual types may be very helpful in making large numbers of hybrids, they may be too sexual for the immediate recovery of apomixis. We are exploring this at the present time. Facultative types with a rather low percentage of sexual offspring may prove to be more useful than fully sexual plants in a breeding program.

Robert C. Buckner - The objective of the hybridization work is to incorporate the palatability and nutritive qualities of ryegrass into tall fescue. Approximately 150 F_1 ryegrass x tall fescue hybrids have been obtained. All of these hybrids have been male sterile and largely female sterile. The following methods have been used to obtain fertility in these hybrids: (1) by backcrossing to tall fescue until fertility is secured and (2) by treating the F_1 hybrid with colchicine in an effort to secure fertility. Fertility has been obtained by both methods. The backcrossed hybrids had progenies established in replicated nurseries for grazing trials when they become fertile. A number have been significantly better grazed than the tall fescue check plants. The well grazed progenies have been inbred to study fertility and segregation for palatability. The majority of the well grazed hybrids were found to be self-fertile. The inbred progenies were established in a spaced plant nursery for grazing trials during 1959. The parents of the inbred progenies are also being polycrossed so that polycross progenies can be evaluated in sod for palatability.

During 1956, five plants were obtained from F_1 hybrids that had been treated with colchicine, one plant was an amphidiploid with 56 chromosomes, three were found to have 70 chromosomes, and one had 42 chromosomes. The 56 chromosome plant produces from 25 to 50 per cent viable pollen. The 56 chromosome plant produced approximately 1000 viable seed when outcrossed in separate tests to tall fescue and to fertile backcrossed hybrids. Plants obtained from this seed were brought into the greenhouse in December, 1958. Fertile plants are being obtained that exhibit both the ryegrass and tall fescue characters. Some of these progenies are being grazed in spaced plant nurseries for palatability evaluation. This new source of genetic material may enable new varieties to be developed with the palatability and nutritive value of ryegrass and the adaptability of tall fescue.

Will A. Cope - In the North Carolina sericea breeding program progenies of three interspecific crosses have been selected through five generations for performance and quality. The three hybrids involve sericea, Lespedeza cuneata with L. hedy-saroides, L. inschanica, and L. latissima.

Average performance of hybrid progenies in F_1 was superior to sericea in stem size and leafiness. Average yield of the hybrids was approximately 80 per cent of sericea; however, the best hybrid lines were superior to inbred lines of sericea. Hybrid vigor for early growth of outcrossed progenies of F_1 lines was superior to outcrosses of sericea inbreds. Average mineral and protein content of the hybrids was not different from that of sericea.

From the F_1 and F_2 's selection was made for individuals superior in low tannin, high protein, fine stems, or leafiness. These selections were backcrossed to outstanding sericea inbreds. Further selection will be made in segregating generations, after which appropriate combinations will be made to take advantage of heterosis.

J. P. Craigmiles - Interspecific hybridization is not peculiar in sorghum since species containing 10 pairs of chromosomes cross readily with each other. Many workers (Quimby, Karper, Ross, Kramer, Burton, et al) have crossed Sorghum spp. for various uses in breeding programs.

At Experiment, Georgia crosses between S. sudanensis var Tift x S. arundinaceum have been made in developing hybrid sudangrass. Crosses between S. vulgare x S. sudanensis var Tift and S. vulgare x S. arundinaceum have been utilized in developing experimental varieties of Suday.

Forage yields of interspecific hybrids as compared to parents are below:

	Avg. dry matter yield	3 locations	Per cent	Leaves
	<u>1957</u>	<u>1958</u>	<u>1957</u>	<u>1958</u>
	<u>lbs</u>	<u>lbs</u>	<u>%</u>	<u>%</u>
<u>S. vulgare</u>	8340	3509	50	60
<u>S. arundinaceum</u>	8414	3307	70	57
<u>S. sudanense</u>	8185	3533	65	52
<u>S. sudanense</u> x <u>S. arundinaceum</u>	-	4848	-	54
<u>S. vulgare</u> x <u>S. arundinaceum</u>	10,565	3896	60	55
<u>S. vulgare</u> x <u>S. sudanense</u>	10,905	4096	53	50

Dr. H. W. Bennett reported on Johnsongrass - Sorghum Crosses (Sorghrass) and discussed the status of the work on Johnsongrass in Mississippi.

Norman L. Taylor - Attempted hybridizations of 38 species of Trifolium with red clover have resulted in one hybrid T. pratense x T. diffusum. This hybrid was sterile at the diploid level but the amphidiploid had a high percentage of viable pollen. Backcrosses to both parents and selfs produced viable seed.

3:05 P.M. Break

3:20 P.M. A Regional Approach to a Breeding Program -

A. A. Hanson, Beltsville, Discussion Leader
H. W. Bennett, Mississippi
C. R. Owen, Louisiana
E. C. Bashaw, Texas
Ian Forbes, Georgia
Glenn W. Burton, Georgia

A. A. Hanson - Dallisgrass improvement work is centered at four locations in the southeastern states - Tifton, Georgia, State College, Mississippi, Baton Rouge, Louisiana, and College Station, Texas. A large part of this research effort is directed along fundamental lines, in an attempt to find procedures and methods that may be used in developing superior forage varieties. Some phases of the research effort are common to more than one location but considerable diversity

is retained by virtue of differences in source material, objectives and techniques. Cooperation is furthered by the exchange of plant materials, hybrids and joint publication of results. Coordination provides for the utilization of recent findings and new leads at all locations, thereby increasing efficiency and the intensity of current research.

H. W. Bennett - Dates of seeding tests have shown that late winter or early spring plantings are most dependable. Seed quality is of extreme importance in establishment and seeding rates should be adjusted on this basis. Owen states that the quantity of seed required to supply 10 live pure seed per square foot when sown on an acre should be used as the base.

Seed-bed preparation materially increases the stand of grass and the increase in stand is usually in proportion to the amount of soil preparation. Mulching with seed hay at the rate of 1 ton per 3 acres is a very satisfactory, but expensive, method of establishing Dallisgrass.

Seed germination is best at alternating temperatures of 20-35° F and periods of light.

Dallisgrass seedlings are strong and competitive but mowing should be practiced if weed growth reaches sufficient height to be clipped.

Moisture supply determines the rate of establishment and growth. Seedlings made in early March (State College, Mississippi) with ample moisture have reached boot and seeding stage by mid-June. A precise statement of the amount of moisture necessary for maximum growth is difficult but tests have shown that increased growth results with application of water greater than an average of 1 inch per week.

Best growth occurs at temperatures above 75° F. Lovvorn found that Dallisgrass produced more top growth under a temperature of 80-90° F. and a short day than under a temperature of 60-70° F and the same day length. Knight found that a high temperature and a 14-hour day is best for greenhouse production of Dallisgrass. Dallisgrass failed to produce heads when grown under an 8-hour day and seed head production is erratic and incomplete under a 12-hour day. Low temperatures inhibit flowering and growth evidently ceases or is very little at 55° F. Temperatures below 70° F greatly affect the time required for the process of blooming. Light becomes the limiting factor for flowering at 60-55° F temperatures. Dallisgrass appears to be more affected by photoperiods in growth and reproduction than several other species of Paspalum.

Top growth and rhizome production is greatly influenced by spacing as shown by the following data:

Green Weight in Grams

Spacing	Harvested for forage			Harvested for seed	
	Tops	Roots	Rhizomes	Roots	Rhizomes
1"	7.0	0.7	3.8	0.8	4.0
2"	11.1	3.8	13.2	5.8	18.3
4"	32.8	10.5	25.0	23.0	47.7
6"	76.4	24.8	43.2	15.0	38.3
9"	108.8	28.7	130.5	20.2	57.2
12"	246.3	27.5	173.5	26.0	81.3
18"	369.5	88.5	239.7	36.7	137.3
36"	487.2	106.0	303.0	39.3	210.0

Carbohydrate content of rhizomes decreases as the stage of growth progresses from vegetative through booting, flowering, and maturity. If only the seed heads are removed (no forage) the plant tends to become determinant in growth and is subject to winter injury and actually decreases in size. Removal of top growth appears to cause rhizomes to maintain size until September at which time top growth ceases but rhizomes increase in size and carbohydrate content.

When harvested close to rhizomes the thicker spacings outyield thinner spacings. Harvested at a 3-inch height there is no significant difference in yield up to a 9-inch spacing. Thicker spacings are earlier. Per acre seed yields are not significantly different for spacings. Per plant seed yields significantly increases as spacing increased.

Rhizome size changes radically as spring growth is produced the second year. The weight of rhizomes in the fall as compared to the weight in the spring after the first forage harvest is as follows:

Green Weight in Grams

Spacing	Harvested for forage		Harvested for seed	
	October	April	October	April
1"	14.5	4.6	12.7	3.3
2"	19.0	13.2	38.0	18.3
4"	37.5	18.8	41.7	23.1
6"	86.3	25.6	226.2	38.3
9"	142.7	53.2	221.0	59.2
12"	202.3	50.8	141.7	106.7
18"	251.2	94.9	278.3	106.6
36"	934.0	173.0	660.0	358.0

Pollen grains germinate very soon after anther dehiscence. The rate of pollen-tube growth is probably rapid, as the stigmas appear to be dry and dying within 2 hours after anther dehiscence. During periods of rainy weather, with accompanying high humidity, some stigmas are alive and not wilted the day after anthesis. Fresh pollen on such stigmas has not induced fertilization, however, indicating that this occurs the day of anthesis, possibly very soon after anther dehiscence. Delay in collecting pollen has resulted in a lowered pollen germination on artificial media.

The time interval between pollination and fertilization, under average summer conditions is between 8 and 12 hours. Zygotes have been found 8 hours after pollination. Differentiation and growth is very rapid during the fourth and fifth days. The embryo is mature 14-18 days after pollination but may be classed as "unripe".

Seed at 21 days and containing 36 per cent moisture may be dried at temperatures as high as 140° F without injury.

C. R. Owen - Plant selections were made from space-planted nurseries which had been established from seed collected from natural stands of Dallisgrass in Louisiana. Seed was harvested from several thousand plants which were field selected for normal vegetative development. Further selecting was done in the laboratory on the basis of yield of seed. Pure seed content was determined on samples from each selected plant. Progeny tests were established in replicated field experiments space planted into rows 42 inches apart and into hills of the same distance. Seed was harvested from each of the progenies at maturity, after which it was threshed, cleaned and analyzed for pure seed.

Sixteen lines were isolated from the progeny experiments which were considered as superior for seed setting, and normal to superior in vegetative vigor. These were planted into a new strains test designed for comparing the yields of forage and seed as well as the quality of the seed. The results of these trials gave rise to the isolation and release of Strains B230 and 430. They were found to be significantly better than the average of the new strains with which they were compared for seed quality and other characteristics observed.

Strains B230 and 430 were planted into separate seed increase blocks of approximately two acres each. They were space-planted into rows for further observation of the plant populations. After two seasons the more persistent clones were removed from the field of each strain, separated into propagules which were transplanted into separate clone-to-row nurseries. Seed was harvested from each of the clone rows the following fall and analyzed for pure seed. Representative clones from the high, intermediate and low seed set classes from each strain were seeded into separate replicated, spaced nurseries the following season. Seed from each plot was harvested at maturity and compared for quality and yield.

It is generally recognized that seed quality of Dallisgrass is affected by environmental fluctuations. The results from progeny evaluation experiments indicate that a significant portion of variation found among plants for seed set

may be heritable. Parent-progeny correlation coefficient for per cent seed for 135 pairs of observations was 0.37, which is highly significant statistically. Seed from twenty-four clones selected from each of strains, B230 and 430, in 1949 were planted in separate progeny nurseries in 1950. Seed setting from the progenies was compared with that of the parents. The results are summarized in Table 1.

Table 1. - Parent-progeny relationship for seed set in two strains of Dallisgrass.

Generations	N	Per Cent Seed Set ¹				Correlation Coefficient	
		Mean		C.V.%			
		B230	430	B230	430	B230	430
Parents 1949	24	50.7	41.3	13.7	6.3		
Progenies 1950	24	31.8	30.3	13.0	9.5	0.85**	0.08

¹Per cent by weight.

**Highly significant P .01

Heritability differences between the two strains for seed set are apparent from the results of these experiments. Strain 430 was less variable for per cent seed set than strain B230. As indicated by the correlation coefficients shown in Table 1, variation in per cent seed set in strain 430 was evidently due to environmental fluctuations and not heritable. Strain B230, on the other hand, gave rise to considerably more variation in seed set among the clones than strain 430. The extent to which this affected the seed set of the progeny is also shown by the correlation coefficient, Table 1. The presence of such differences between strains isolated from common Dallisgrass is indicative of the divergent types which may be isolated from this grass by plant selection from natural stands. Other strains are on hand which are superior to the average but not significantly better than these strains for seed formation.

E. C. Bashaw - The available accessions of Dallisgrass may be grouped into four biotypes on the basis of morphological characteristics. These types include: common, purple-anthered Dallisgrass; a yellow-anthered mutant otherwise identical to common; a semi-prostrate, nearly sterile, purple-anthered type and an erect, yellow-anthered type with highly pubescent spikelets. These four biotypes comprise three cytological groups shown in the following table.

Chromosome numbers and microsporogenesis in Dallisgrass

Strain	Growth habit	Anther color	Chromosome number	Metaphase	Anaphase
Common	upright	purple	50	20II,10I	10 laggards
Mutant	upright	yellow	50	20II,10I	10 laggards
P.I.235362	semi-prostrate	purple	40	10II,20I	20 laggards
P.I.233053	erect	yellow	40	20II	regular

Studies of embryo sac development and breeding behavior have been conducted to determine the methods of reproduction of the four biotypes. The results of these studies indicate that the erect, yellow-anthered type reproduces sexually. Megasporogenesis, embryo sac development and embryo-genesis are normal in this type and there are no indications of irregular nucellar development.

Common Dallisgrass and the other two biotypes reproduce by apomixis. The megaspore or developing embryo sac degenerates and is replaced by a large number of active nucellar cells. The nucellar cells form multiple embryo sacs which frequently produce one or more proembryos prior to anthesis. Endosperm development does not occur until after pollination and apparently pollination is necessary for maturation of the embryo. Thus, reproduction is by apospory and pseudogamy. The uniformity of progeny appearance and the absence of aneuploids suggest obligate apomixis. From all indications the mechanism of apomixis is the same in all three biotypes.

Further evidence for the method of reproduction has been obtained from hybridization studies. All hybrids that have been produced using common Dallisgrass as the female parent have resulted from the fertilization of unreduced eggs.

Our studies suggest that the low potential seed set in common Dallisgrass may result from competition for nutrients among the large number of multiple embryo sacs. Further reduction is often caused by unfavorable environmental conditions. The fact that Dallisgrass is apomictic does not eliminate the possibility of favorable mutations. There is some indication of heritable differences for seed set within common Dallisgrass. While there is apparently a limit to the possible potential seed set in common Dallisgrass, some progress may be made in selecting more fertile lines.

Ian Forbes - H. W. Bennett (State College, Mississippi) produced the hybrid P. dilatatum (common type, $2n = 50$) x P. malacophyllum ($2n = 40$). Bennet and E. C. Bashaw (College Station, Texas) found that the F_1 ($2n = 70$) frequently formed 5 Ivs, 15 IIs, and 20 Is. The F_1 had hybrid vigor, "low" seed set, and ergot resistance. Segregation in the F_2 for plant morphology, and the occurrence of aneuploids ($2n = 52, 54, \text{ and } 65$) indicates that the F_1 is sexual. The cytological

observations indicate some allosydesis of chromosomes at meiosis in the F_1 , indicating that the two parents have some homologous chromosomes in common. Further study of the F_2 and later generations is needed to determine if selections having high forage production, high seed set, and ergot resistance can be obtained.

Bashaw produced the hybrid P. dilatatum (common type, $2n = 50$) x P. dilatatum (yellow-anthered, erect type, $2n = 40$). The F_1 has 70 chromosomes and forms 20 IIIs plus 10 Is at meiosis. This cytological behavior indicates that the two parents may differ by only one 10 chromosome genome. The F_1 and its progeny are completely apomictic. It has hybrid vigor but sets only 10 to 15% seed.

G. W. Burton (Tifton, Georgia) produced two hybrids with the cross P. dilatatum (yellow-anthered, erect type, $2n = 40$) x P. dilatatum (common type, $2n = 50$). Nothing is presently known of the cytology of these hybrids. One hybrid gave an apomictic F_2 and the other segregated in the F_2 . None of the F_2 plants showed economic promise. Most of the segregates resembled the female parent, and some of the segregates set seed as well as the highly fertile female parent.

Burton produced the dilatata hybrid P. urvillei ($2n = 40$) x P. malacophyllum ($2n = 40$). The F_1 ($2n = 40$) had vegetative hybrid vigor, but was highly sterile, producing only a few seeds by apomixis. Ian Forbes (Tifton, Georgia) found that the F_1 frequently formed 15 IIs and 10 Is at meiosis, indicating that the parents had some homologous chromosomes in common. Forbes doubled the chromosome number of this hybrid to $2n = 80$, at which chromosome level pollen shed and seed set improved in the C_1 generation. Selection in later C generations may further improve seed set while maintaining good forage production.

Burton produced the hybrid (P. urvillei x P. malacophyllum) ($2n = 40$) x P. dilatatum ($2n = 50$). The F_1 ($2n = 60$), was immune to ergot, highly productive of forage, and sterile. The few offspring produced by the F_1 were mostly apomicts with a few dwarf or lethal (at young plant stage) off-types. Forbes found that one of the dwarf off-types had ca. 98 chromosomes, indicating that unreduced F_1 eggs were occasionally fertilized.

Burton produced the hybrid P. dilatatum ($2n = 50$) x P. malacophyllum ($2n = 40$). The hybrid ($2n = 40$) did not produce much forage, and it was highly sterile except for an occasional apomictic seed. Forbes found that the hybrid frequently formed 15 IIs and 10 Is at meiosis. This indicates that the two parents have some homologous chromosomes in common.

Burton produced the hybrid P. dilatatum (semi-prostrate type, $2n = 40$) x P. dilatatum (yellow-anther, erect type, $2n = 40$). Forbes found that this hybrid had $2n = 60$ chromosomes. The F_1 had hybrid vigor but was highly sterile and never shed pollen. Backcrosses F_1 ($2n = 60$) x yellow-anther type ($2n = 40$) gave 105 apomicts like the F_1 and 26 segregates. All of the latter were inferior in vigor to the F_1 .

Forbes doubled the chromosome number of *P. dilatatum* (semi-prostrate type, $2n = 40$) which, judging from its meiotic behavior (10 IIs plus 20 Is at diakinesis), is the result of a wide cross. This auto-allo-octoploid ($2n = 80$) is highly sterile, and is much less productive of forage than 40-chromosome material. This material may have values as a male parent, since it sheds pollen rather well.

The speaker feels that the following points are worth consideration by grass breeders in this group.

1. Most hybrids with common or semi-prostrate Dallisgrass as the female result from the functioning of unreduced eggs and, thus, high levels of ploidy. Multiple hybridization or backcrossing among 40 chromosome species in *dilatata* have thus far also resulted in very high chromosome numbers on account of the functioning of unreduced eggs.
2. Loss of vigor resulted at the 80-chromosome level in prostrate Dallisgrass and dwarfing occurred at the ca. 98-chromosome level in Burton's multiple cross (above).
3. Bashaw and Forbes found that yellow-anthered, erect Dallisgrass ($2n = 40$) from Uruguay forms 20 IIs at diakinesis, and Bashaw's studies of embryo sacs gave no evidence for nucellar apospory, so this grass may be sexual despite its lack of variability. On a morphological basis, this grass appears closely related to common Dallisgrass. Cytologically yellow-anther, erect Dallisgrass appears to have the chromosome genome constitution AABB or $A_1A_1A_2A_2$, while common appears to have AABBC or $A_1A_1A_2A_2C$. Thus, to construct an improved common Dallisgrass may require a successful fertilization of an unreduced egg of yellow-anthered, erect Dallisgrass with pollen from a 20-chromosome species having the genomes CC. The latter species must contribute to the less erect habit and less hairy floret characteristics of common Dallisgrass. Additional hybridization attempts using yellow-anthered, erect Dallisgrass or its 20-chromosome progenitor or progenitors (if they can be found) may result in productive, sexual, and fertile hybrids at a lower level of ploidy.
4. The introduction of 20-chromosome Paspalum species from South America may be the key to Dallisgrass improvement.

Glenn W. Burton - One thousand spaced plants from untreated seed of prostrate Dallisgrass were compared with 1,000 spaced plants from the same seed treated at the Brookhaven National Laboratory with 15- and 20-hour dosages of thermal neutrons and 20,000- and 30,000-r units of X-rays. The number of vegetative offtypes, or "mutants," per 1,000 plants in this highly apomictic variety increased from 80 for the check to 206, 346, 110, and 239, respectively, for the R_1 of the treatments listed above. Floral "mutants" per 1,000 plants numbered 30, 59, 125, 34, and 77, respectively. The 20-hour thermal-neutron treatment produced 38 of 81 possible vegetative classes as compared with 22 for the untreated check. Ergot resistance could not be found in the R_1 or in some 24,000

spaced R_2 plants. Offtypes occurring in some 15-plant R_2 progenies bred true in the R_3 generation, proving that offtypes had arisen by sectoring and apomixis had not been broken. Thus, R_2 and R_3 should be designated R_1A_1 and R_1A_2 (A_1 = first apomictic generation). Preliminary relative forage yields of the 9 "best" R_1A_2 progeny for each treatment averaged 100, 103, 99, 93, 91, respectively. One R_1A_2 progeny from seed treated with thermal neutrons for 15 hours yielded significantly more than the checks.

4:15 P.M. New development in forage breeding - Volunteers.

Wednesday June 10, 1960

Plant Management - Animal Session
E. M. Evans, Alabama, Presiding

1:15 P.M. Panel Discussion - New Fundamental Research on Forage Physiology and Microclimatology

D. E. McCloud, Beltsville - Panel Leader
S. H. West, Florida
E. G. Beinhart, Jr., South Carolina
C. Y. Ward, Virginia
C. W. Alexander, Beltsville

Grassland agriculture is extremely complex. Pasture management practices have been largely developed on the basis of subjective judgments of the farmer, rancher, or in grazing experiments by the research operator. Before real progress can be made the various facets of pasture production and management problems must be studied separately. The fundamentals of plant physiology and environmental influence of the microclimate must be isolated and studied. After the fundamentals are understood, sound management practices can be developed. This panel discussion is designed to present some of this newer basic research.

S. H. West - The future improvement of pastures in Florida awaits the development of accurate and rapid techniques for the selection of better adapted legumes. The persistency of pasture plants is dependent upon the ability of the numerous individual plant processes and reactions to proceed under an extremely wide variety of environmental conditions. The vigor and subsequent total production of these persisting plants is regulated by how close to optimal rates the individual plant processes proceed.

The task of screening for adapted plants is difficult because:

1. The inheritance of quantitative characters is considered additive, thus the recognition of intermediate types is extremely important.
2. Environmental conditions cannot be controlled in the field or nursery and any given condition is seldom duplicated.

Recent observations indicate that a more accurate system of screening for plants which resist the influence of extreme environmental factors is possible and feasible. Plants which survive at a critical-reproducible temperature in a greenhouse or growth chamber can be screened further by testing their glycolytic enzymatic system for ability to function at high temperatures.

E. G. Beinhart, Jr. - Three characteristics common to most growth chambers are: (1) reasonably accurate temperature control; (2) light intensities usually not exceeding 2,000 foot-candles at plant height; (3) high operating costs.

Because of these characteristics, certain types of studies are best suited for growth chambers. Temperature effects on growth can be studied in considerable detail. Light intensities in chambers are far below maximum sunlight, but the effects of light intensity can be studied by imposing gradients within chambers by means of shades or different plant-to-light distances. Because of operating expense, planning of experiments is very important. A properly planned and executed growth chamber experiment may be less expensive than a greenhouse or field experiment, particularly in terms of the amount of information obtained per dollar spent.

Maximum information is gained by measuring as many different parameters of growth as possible during the course of an experiment and relating these various measurements to one another to determine the causes of overall plant responses. By this multiple measurement approach, growth chamber experiments lead to predictions of plant responses which can be tested under field conditions.

Studies with white clover indicate that high temperature reduces total dry matter production by decreasing rate of leaf production and leaf size, thus greatly reducing leaf area available for photosynthesis. Growth is greatly increased by increasing light intensity at a high (86° F) day temperature, and this increase results from a higher rate of leaf area production, rather than from higher photosynthetic rates.

Discussion:

Killinger: At what light intensity did the greatest increase in growth occur?

Beinhart: The greatest increase was the difference in growth between the 600 and 900 ft.-candle treatments.

Coleman Y. Ward - A "microclimate" is a climate of a small space; it is a small part of that climate measured by the U. S. Weather Bureau which covers large areas. The microclimate may be 15 M. in a forest, 1 M. in a tall grass meadow, or less than .1 mm. around the surface of a leaf.

The microclimate of plants is extremely rigorous and in a constant state of change. Plants absorb incoming radiation from the sun and outgoing radiation from the soil; thus the plants per se influence the microclimate.

Recently renewed interest has been shown in measuring soil and plant temperatures, soil moisture, wind velocity, humidity and evaporation of moisture in the

microclimate of forage sods.

There remains a real need for better techniques and equipment for measuring the afore mentioned factor and applying the findings to plant responses in the field.

C. W. Alexander - Leafage and its supporting structure is the product of any pasture. It is produced under the influence of several physical factors of the environment, chief among which are water, nutrients, and light. Of these, light has been the least studied, and consequently the least understood, as a factor of the plant community. This lack of study has been largely due to difficulty in determining the relationship of the total leaf surface of the community to the light supply. The need for a useful term expressing leaf area has aggravated this difficulty. The LAI concept provides one means of representing total leaf area and allows consideration of its interrelationship with the light environment.

LAI, simply, is the ratio of leaf area to ground area, the leaf area per unit area of land. It is a quantitative concept devised by Watson (1) to express the ratio of total leaf surface to soil surface. A LAI of 1.0 means that leaf surface area and ground area are equal. A LAI of 2.0 means that there is twice as much leaf area as ground area and etc. In discussing the significance of this relationship he wrote:

"A comparison of the leaf area per plant of different species is of little interest, for these must be highly dependent on the spacing of the plants, which varies in accordance with normal agricultural practice. The measure of leaf area which is relevant to the comparison of agricultural yields, that is, of the weights of different crops produced per unit of land, is the leaf area per unit area of land, which it is proposed to call the Leaf Area Index (LAI)"

So LAI is a description of the leaf surface of the whole crop and becomes a parameter influencing the light supply within the plant community.

It is evident that the development of a leaf system capable of intercepting a high proportion of the incoming light energy is of primary importance in the growth of plants. At values of LAI below this level all the available light is not utilized; at higher values of LAI shading of lower leaves may actually result in reduced growth rate. This phenomenon was evidenced in plot studies by New Zealand and Australian workers who found that growth rate increased until such time as most of the incident light energy was intercepted. Beyond this point it was constant, finally declining.

Recent work at Beltsville, utilizing a CO₂ analyzer, also indicated an optimum LAI for plant growth. Pearl millet plants were placed in a sealed chamber at various densities and their photosynthetic rates measured. Up to a density of 6 plants per sq. ft., or an LAI of 11.7, photosynthetic rate increased. Beyond this density it decreased. When the plants of the maximum density were cut, reducing the LAI but exposing more leaf surface to light, the photosynthetic rate increased. Continued cutting caused further increase until an 11-inch height was reached (LAI = 14.3). Beyond this point the rate

rapidly diminished. Thus maximum returns in terms of growth would be obtainable at the LAI giving maximum photosynthetic rate, apparently around 13.0 in millet. If a rapid means of determining LAI were available it might serve as a more critical parameter of management than such a value as height of cut or physiological age.

Although most means of measuring leaf area are tedious, several have been devised. Some of these are....

1. Visual estimation
2. Measurement of Dimensions
3. Planimetry
4. Light Interception
5. Air Passage Interception
6. Volumetric Displacement
7. Weight to Area Relationship

The significance of the LAI concept justifies further search for a more facilitative technique of measuring leaf area.

Although there are many areas of the world in which competition for light is not the limiting factor in growth, certainly under conditions of non-limiting water or nutrient supply the study of the more effective use of available light and utilization of LAI as a criterion of light interception is deserving of consideration.

Discussion:

Lucas: Did increased respiration or increased photosynthesis account for the difference in CO_2 absorbed?

Alexander: Background respiration was accounted for and found to be negligible. The difference was undoubtedly a result of increased photosynthesis.

Taylor: What is the actual relation of light intercepted by L.A.I.?

Alexander: With maximum L.A.I., about 95% of the light was intercepted.

Taylor: If an L.A.I. is about 12, what percent of the solar energy is being absorbed by the plants?

McCloud and Alexander: This is dependent upon the absorption value of chlorophyll and a number of other factors. However, only about 2% of the radiant energy is used in photosynthesis. Most of the radiant energy is associated with transpiration.

2:15 P.M. Panel Discussion - Are Species of Animal, Age of Animal and Season of Year Important Factors in Determining the Nutrient Qualities of Forage?

W. A. Hardison, Virginia, Panel Leader
P. G. Woolfolk, Kentucky
G. E. Hawkins, Alabama
M. E. McCullough, Georgia
J. P. Fontenot, Virginia

P. G. Woolfolk - In determining the nutritive quality of forage, the question often arises on whether to use sheep or cattle as tester animals. The most obvious advantage of sheep is the possibility of getting a larger number of individual animals per forage plot, thereby increasing the validity of the results. Sheep are generally accepted as excellent animals for ruminant digestibility studies. In fact, most, but not all, of our feeding allowances in which digestibility figures have been used are based on studies with sheep. This is due to the fact that a great many more digestibility studies have been conducted with sheep. In general, digestion of the various nutrients by sheep is approximately the same as digestion by cattle. There is some evidence in the literature that sheep are more efficient converters of protein but this difference is of a minor nature.

In grazing studies, utilization of nutrients consumed is approximately the same as for cattle, providing the quality of forage consumed is of a similar nature. However, sheep have much greater ability to select herbage and usually consume higher quality herbage than cattle. This is not only due to selection of more palatable plants but also to selection of the more leafy succulent parts of individual plants. In studies on mixed forages, this certainly is a limitation to be considered.

Grazing behavior of the two species is probably different although extensive studies on this are not available. Sheep are susceptible to hot weather and graze only during the cooler parts of the day in warm areas. This grazing behavior may be upset considerably in sampling fecal excretion of sheep. This is probably also true to a certain extent in studies with beef cattle but with dairy cattle that are usually handled twice daily, this becomes a minor problem.

Shearing, control of internal parasites and general management of sheep are additional problems that have to be faced as compared to cattle.

In studies in which digestibility indicators are involved, procedures have been more clearly defined for cattle than for sheep, however, the chromogenic oxide and the lignin-chromic oxide methods can be used quite successfully with sheep. Also, sheep lend themselves quite well to studies in which harnesses and bags are to be used for fecal collections. Bulk of samples collected, handling of samples and actual sampling can be carried out with much more ease with sheep.

Cattle are probably more adaptable and offer less limitations in large scale studies while sheep lend themselves to studies on smaller plots and are often favored in studies in which total fecal collections are required.

G. E. Hawkins - A satisfactory small tester animal is needed: (a) for evaluation of the nutritive qualities of new strains of forages at an early stage of development, (b) in studies of the energy values of feeds of different species, and (c) in studies of factors that affect the energy value of feeds for farm animals. The rabbit has several characteristics of such a tester animal, including: (a) small size, (b) can subsist on forage, and (c) is easy to handle.

Evaluation of data in the literature (Crampton, et al. 1940, and Hawkins, 1957), which compares seven forages, reveals that the mean digestibility of forage dry matter, organic matter, crude protein, crude fiber, cellulose and nitrogen-free extract by steers was greater than by rabbits and the correlations were 0.61, 0.56, 0.95, -0.08, 0.34, and 0.66, respectively. Rabbits digested crude protein in oat grain more efficiently than sheep, but digested less cellulose than the sheep (Weiske, 1894). Differences in digestibility of the oat grain dry matter by rabbits and sheep were small. Digestibility of feed fractions by sheep and rabbits increased as the amount of feed eaten decreased. Also, digestibility of feed components by rabbits decreased as the crude fiber level of the ration increased (Eriksson, 1952).

Data summarized by Blaxter 1956, show that a kg. of starch had a higher net energy value for rabbits than for cattle or sheep. Also, the net energy value of a kg. of fat or protein was different for these animal species.

The information available is of such a limited scope that the value of the rabbit as a tester animal in forage evaluations is questionable. From the data reviewed, the rabbit cannot be considered as a satisfactory tester animal for precise evaluations of feedstuffs. Nevertheless, it appears that the rabbit is a satisfactory tester animal for crude evaluations of the relative digestibility of crude protein in forages. The forages evaluated by steers and rabbits have involved several species. Within forage species, the correlations between digestibility by steers, or sheep and rabbits may be much higher than across forage species.

Discussion:

Paltridge: In comparing the digestibility of feeds by rabbits and cattle, did you compare two or more feeds?

Hawkins: Alfalfa hay and sericea hay were compared in the Alabama experiment.

M. E. McCullough - The period from birth to maturity is characterized by waves of growth and changes in body composition. The changes in body proportions are brought about by the different parts growing at different rates; some, such as the head, grow rapidly in early life and are proportionally large then; while later other parts such as limbs take on more rapid growth and then form a larger proportion of the body.

In general, a wave of growth, beginning at the head, spreads down the trunk and secondary waves which start at the extremities of the limbs pass upward and meet at the junction of the loin and last rib. Similar growth gradients also exist between different tissues in the body, which grow in the following general order - brain, bone, muscle and fat. In forage evaluation we are concerned with these growth waves, with particular interest in the muscle and fat deposition.

The three basic changes which affect forage evaluation are:

1. A change from growth to fattening
2. The increasing cost of maintenance
3. The change in dietary requirements

Changes from Growth to Fattening

From the data presented by Ellenberger, et al^a and Ritzman and Colovas^b we have calculated the change in response to digestible protein and TDN by dairy heifers during various stages of growth. The data are shown in Table 1.

Table 1. The Influence of Increasing Digestible Protein and TDN on Animal Response at Various Ages. (Dairy Heifers).

		Increase gain due to 10% increase in mean intake of:			
	<u>A.D.G.</u>	<u>Dig. Prot.</u>	<u>T.D.N.</u>	<u>R</u>	
<u>Vermont</u>					
1 - 90 days	1.19	+ .16	- .04	.634	
1 - 180 days	1.06	+ .06	+ .06	.834	
1 - 270 days	1.38	- .08	+ .24	.939	
1 - 360 days	1.27	0	+ .16	.920	

<u>New Hampshire</u>					
350 - 950 lbs.	1.68	+ .11	+ .14	.535	

$$Y = a + bX_1 + cX_2$$

Where: Y = average daily gain

X_1 = digestible protein

X_2 = total digestible nutrients

^aVermont Agricultural Experiment Station Bulletin 564 and others in the series.

^bNew Hampshire Agricultural Experiment Station Technical Bulletin 80.

This change in body composition is accompanied by a change in total energy required for a unit increase in body weight. In Table 2 are shown representative data from the work of Ritzman^b relative to the influence of age on storage of TDN from feed.

Table 2. The Influence of Age on the Use and Efficiency of TDN. (Dairy Heifers)

Average Body wt.	TDN intake/		A.D.G.	Gain as		TDN/lb. of gain	
	100# weight	Daily		Flesh	Fat	Gross	Above maint.
(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
340	1.69	5.74	1.86	1.45	.38	2.01	1.60
624	1.51	9.42	2.06	1.32	.63	4.56	2.14
977	1.19	11.62	1.45	0.58	.78	8.00	2.49

The last two columns relating TDN per pound of gain, were calculated on the basis of a constant value of maintenance. This may or may not be correct, but the relative change is probably unaffected.

The overall effects of these changes are shown in Table 3 relative to their effects on forage evaluation. In the table it was assumed that the data in Table 2 was transferred directly to a pasture such as a temporary winter forage. The pasture was stocked on an equal weight of animals per acre basis.

Table 3. The Influence of Animal Size on Forage Evaluation

4000 lb. dry matter per acre (75% TDN) (3000 lb. TDN)					
Average wt. of animal	Animals per acre	Animal days/acre	Total gain acre	TDN used for maintenance	gains
(lb.)	(no.)		(lb.)	(lb.)	(lb.)
340	5.8	574	1067	1293	1707
624	3.0	318	655	1599	1401
977	2.0	258	374	2069	931

Finally, it should be pointed out that normal response can result from a wide variation in rations so long as they are consumed in amounts adequate to meet the nutritional requirements of the animals.

J. P. Fontenot - A limited number of experiments have been conducted by other research workers with cattle and sheep fed the same ration at different times of the year. It appears, from reviewing these experiments, that time of the year at which a digestion trial is conducted may influence the digestibility of at least some of the ration components.

Digestion trials with wethers fed the same ration in the spring of 1958, fall of 1958 and spring of 1959 have been conducted at the Virginia Agricultural Experiment Station to study the effect of season of the year on digestibility. It was found that season of the year had no marked influence on the apparent digestibility of crude protein and crude fiber. Season did influence nitrogen-free extract digestibility; the average digestibility was higher in the fall than in the spring. The net result was a slightly higher average dry matter and organic matter digestibility and slightly higher average TDN in the fall. Age of the sheep had no marked influence on crude protein and nitrogen-free extract digestibility. When the wethers increased in age from approximately 1 to 1.5 years average crude fiber digestibility increased markedly. When the age of the sheep increased from approximately 1.5 to 2 years no additional effect was observed in this respect. There was a slight increase in average TDN when the sheep increased in age from approximately 1 (spring, 1958) to 2 (spring, 1959) years.

Discussion:

Granger: Was the animal variation within seasons greater or less than the animal variation between seasons?

Fontenot: There was not an appreciable difference.

3:30 P.M. Break

3:45 P.M. Effect of Diet on Milk and Animal Fat - R. W. Engel, Virginia

The fat depots of animals are composed mainly of simple fats, or triglycerides. In contrast, organ fats also contain fairly large proportions of phospholipides, cholesterol, and cholesterol esters. When animals are fed on rations containing relatively large amounts of fat, much of the fat of the ration may be assimilated directly, resulting in body fat stores with a fatty acid composition approaching that of the ration. The extent to which this process can be demonstrated depends upon the nature of the digestive system of the animal and the composition of the ration that the animal will tolerate. For example, hogs will tolerate rations high in fat, and therefore, soft pork, or pork in which the depot fat is composed mainly of unsaturated fatty acids, can be produced readily by feeding rations high in unsaturated fatty acids (vegetable oils). Herbivorous animals, and particularly ruminants, will not tolerate rations high in fat. Consequently, the extent to which the composition of depot fat of ruminants approaches the fatty acid composition of the ration is greatly limited. This process nevertheless can be demonstrated, even in ruminants.

The ruminant is also unique in that the bacterial fermentation which occurs in the rumen converts a large amount of protein and carbohydrate from the ration into short carbon-chain fatty acids which are then synthesized into longer carbon-

chain fatty acids and stored in the depot fats as such. This process not only influences the nature of the depot fat stored but also influences the composition of the fat of the milk. Thus, the milk fat of ruminants is characterized by the presence of considerable amounts of short carbon-chain fatty acids, while the milk fat of non-ruminants is devoid of short carbon-chain fatty acids. Again, the overall fatty acid composition of cows' (ruminant) milk is less subject to changes inducible by the fat in the ration than is the case with non-ruminants, such as swine or human beings, because the amount of fat that can be tolerated by the ruminant is small when compared with the non-ruminant.

About 90 to 95 per cent of the fatty acids in the depot fats of animals consist of fatty acids with a carbon-chain length of 16 carbon atoms (palmitic acid) or 18 carbon atoms (stearic acid or unsaturated derivatives of stearic acid). Usually, these are present in the ratio of one molecule of palmitic acid to two molecules of a mixture of stearic acid and its unsaturated derivatives.

Although there is considerable variation, in general, fats in the leaves and stems of pasture plants contain about 10 per cent of palmitic acid, about 5 per cent of stearic acid, and about 85 per cent of unsaturated derivatives of stearic acid. Seed fats in the plant kingdom are likewise characteristically high in the unsaturated fatty acids of 18 carbon-chain length. One might suspect, then, that pasture plants constitute a ration in which the fat component is highly unsaturated and thus should produce fat depots (or milk fat) of a soft character. The situation, however, can be likened to the hog when fattened on corn. The fat in corn is highly unsaturated, just like the fat in pasture plants, but in both cases the total fat content is only 4 per cent or less. Thus, the hog fattened on corn synthesizes most of its body fat from starch, whereas the grazing steer would, through rumen bacterial fermentation, synthesize most of its body fat from short carbon-chain fatty acids. In both cases, a firm depot fat is laid down.

It should be emphasized here that our knowledge of the detailed composition of the component fats of the leaves and stems of agronomically important plant species is far from complete. There is some evidence that isomers of oleic acid (the acid with one double bond between carbons 9 and 10 of stearic acid, or the least unsaturated of the 18 carbon-chain series) appear in cows' milk fat in greater concentration when cows are consuming pasture herbage. These isomers of oleic acid, characterized by shift of the double bond to the 10 or 11 carbon atom, are present in pasture herbage in small amounts. The possibility also exists, however, that isomerization takes place in the rumen, as a result of bacterial fermentation, or in the animal tissues.

That small amounts of feed fat find their way into the tissue fats and milk fats of ruminants cannot be denied. A well-known example is the increase in hardness of butterfat when cows are fed rations relatively high in cottonseed oil. Since cottonseed oil is high in unsaturated fatty acids, one would expect an increase in softness of butter. However, this type of ration has the effect of decreasing the amount of short carbon-chain fatty acids in milk fat, which more than offsets the softening effect of the unsaturated fatty acids.

From this discussion, it is clear that

- (1) Agronomic crops contain fats that are composed largely of fatty acids with a high degree of unsaturation.
- (2) Animals consuming such crops deposit body fats that assume the characteristics of the fat in the feed to a small degree in ruminants and to a much greater degree in non-ruminants.
- (3) The greater influence of food fat on body fat in the non-ruminant species is evident mainly because these species can tolerate high-fat rations whereas such rations are poorly tolerated by ruminants.
- (4) The extent to which small amounts of unusual unsaturated fatty acids of the ration may find their way into ruminant depot fats and milk fats is at present not clearly understood.

4:00 P.M. Chemical Composition and the Digestibility of Forages -

H. L. Lucas, Jr., North Carolina

W. W. G. Smart, Jr., North Carolina

A quantitative theory for the relationships between digestibility and feed and fecal composition was briefly reviewed (see Report of 15th SPFCIC, Clemson, June 1958). From the standpoint of this paper the pertinent outcome of the theory is as follows:

When the chemical fraction determined in a feed satisfies certain critical restrictions (i.e. the fraction is a nutritive entity) there is a linear relationship between the digestible amount of the fraction in the feed and the amount in the feed and this relationship is the same for all feeds.

The following equation was therefore fitted to data:

$$y = a + bx \quad (1)$$

y = digestible amount of a chemical fraction in the feed
dry matter (%); recoverable amount for lignin
x = amount of the fraction in the feed dry matter (%)
a = intercept; can represent the fecal material not
coming from feed
b = slope, can represent the "true" digestion coefficient
(decimal fraction not percentage)

Shown in table 1 are the results of fitting (1) to data on crude protein and ether extract from Schneider's "Feeds of the World" for different species of animals.

Table 1. Results of fitting (1) to Schneider's compilations (all kinds of feeds)

Species	Protein				Ether Extract			
	Range of x	a	b	$s^{1/}$	Range of x	a	b	$s^{1/}$
Sheep and Goats	0.2 - 96.5	-3.72	.954	1.53	0.3 - 49.3	-.93	.947	.82
Cattle	3.0 - 80.7	-3.87	.924	2.21	0.4 - 28.9	-1.19	1.021	.27
Swine	1.9 - 93.1	-4.08	.960	3.27	0.1 - 32.8	-1.10	.993	1.47
Horses	2.1 - 41.3	-2.61	.899	2.00	0.2 - 8.2	-.68	.703	1.17

$1/s$ = root mean square deviation from the fitted line.

Digestion trials were run on four sets of forage with the several samples in each set harvested at different stages of maturity. Two sheep were used on each sample.

Species	Year	Number of Samples
	1957	8
Alfalfa	1958	10
Fescue	1957	7
	1958	13
Total		38

For each material measured in the feed, equation (1) was fitted to each of the four sets separately and to the four sets combined. From such data conclusions may be drawn as follows:

Result	Conclusion
I. Within limits of experimental error, $a \leq 0$, $0 \leq b \leq 1$, a's and b's consistent from forage to forage and year to year and small root mean square deviation from fitted line	Theory and chemical fraction both acceptable (fraction is a nutritive entity)
II. Conditions of I not met, but chemical fraction is a pure chemical compound	Theory unacceptable and needs improvement
III. Conditions of I not met, and chemical fraction is not a pure chemical compound	Theory can be tentatively retained, but fractionation procedures must be improved

Statistical results are summarized in table 2. Disagreement of a's and b's between years and/or types of forage is evidenced by a larger residual square for "All Samples Combined" than for "Four Sets Pooled."

There is no evidence that the theory is unacceptable. Supporting the theory are results for crude protein, ether extract and hot water soluble sugar. These three fractions also can be considered to be close enough to nutritive entities to serve for many purposes, but improvements can still be made. As expected, crude fiber and N-free extract are poor fractions for characterizing feeds. Crude cellulose (Matrone, Ellis, Maynard) and other CHO are not much better. Break-down of carbohydrates into hot-water, 4% H_2SO_4 and 72% H_2SO_4 soluble portions provides much improvement, but even better methods are clearly needed.

Work is now in progress to test the effectiveness of determining, among other things, pentosans and true cellulose. Further testing of the theory will be done.

Table 2. Summary of results of fitting (1) to the four sets of forages.

Material Studied	All Samples Combined						Residual Mean Square		Mean Square Between Duplicate Trials	s ¹ / Corrected for Variation Between Duplicate Trials
	Range of Content %	a		b	s ¹ / s _a	s ² / s _a	s ³ / s _b	All Samples Combined		
Ash	5.07 to 10.51	-1.73	.743	.67	.44	.175	.4543	.4592	.2004	.51
Crude Protein	7.26 to 32.35	-4.02	.959	.60	.22	.011	.3657	.3190	.2699	.31
Crude Fiber	17.32 to 38.86	7.05	.355	3.39	2.62	.072	11.5145	2.3421	1.5827	3.19
Ether Extract	4.00 to 6.81	-1.06	.860	.44	.35	.066	.1943	.0966	.0226	.42
N-free Extract	35.59 to 51.20	4.75	.607	3.42	3.78	.089	11.7065	8.3700	1.6867	3.21
Hot Water Sol. Sugar ¹⁴	2.18 to 12.22	-.24	1.000	.07	.02	.004	.0046	.0042	.0049	0
4% H ₂ SO ₄ Sol. Sugar ¹⁴	3.99 to 24.36	.06	.691	1.29	.38	.028	1.6582	1.3588	.2780	1.19
72% H ₂ SO ₄ Sol. Sugar ¹⁴	10.38 to 39.04	1.21	.659	2.40	.89	.037	5.7727	3.9614	.9661	2.22
Crude Cellulose	18.54 to 37.44	-.06	.683	3.13	1.63	.070	9.7698	2.2828	.9284	3.05
Other CHO ⁵	26.17 to 42.40	2.35	.731	2.56	.71	.082	6.5316	3.6497	.7949	2.43
Lignin	3.30 to 11.99	.06	.857	.70	.26	.037	.4841	.4659	.2349	.51

^{1/} s = root mean square deviation from the fitted line

^{2/} s_a = standard error of a

^{3/} s_b = standard error of b

^{4/} Reducing substances expressed glucose

^{5/} Crude fiber plus N-free extract less cellulose and lignin

Thursday June 11, 1959

Morning Session
P. G. Hogg, Mississippi, Presiding

8:15 A.M. Grass Pellets Versus Green Chop or Grazing - Orien Brooks, Midville, Georgia

A 100-day forage evaluation experiment was completed at the Southeast Georgia Branch Experiment Station, Midville, on March 15, 1959.

Treatments consisted of:

1. Coastal Bermudagrass pellets
2. Six parts ground snapped corn, 1 part cotton seed meal and Coastal Bermudagrass hay, free choice.
3. A ration of one-half Coastal pellets and an unpelleted mixture of cracked shelled corn, 7 parts, and cottonseed meal, 1 part.

Duplicate lots of 5 steers each weighing 600 pounds were used as test animals.

The Bermudagrass had been fertilized with 500 pounds 4-12-12 in the spring and 75 pounds of N preceding each cutting.

One half the Coastal Bermudagrass pellets fed were made from forage harvested before September 1 and were made from grass 5 weeks of age with a protein content of 16.50%. The other half of the Coastal pellets were made from grass harvested in late October that was 7 weeks of age. The protein content of this grass was 9.75%.

SUMMARY

<u>Ration</u>	<u>Daily gains</u>	<u>Feed to gain ratio</u>
1. Coastal pellets	2.56 lbs.	7.4
2. Ground snapped corn and cottonseed meal (unpelleted)	2.62 lbs.	8.1
3. 1/2 ration of Coastal pellets and 1/2 ration unpelleted cracked corn and cottonseed meal	2.96 lbs.	6.7

Carcass data will be available in the near future.

The work was completed by O. L. Brooks, E. R. Beaty and R. A. McCreery of the Georgia Agricultural Experiment Stations.

Pelleting hays for growing cattle as compared with feeding the same material long (as customarily stored) may be expected to have the following advantages:

- (1) The daily dry matter consumption will be materially increased
- (2) The rate of passage of ingesta through the digestive tract will be increased
- (3) On ad libitum feeding, the pellet-fed steers will gain at a significantly faster rate
- (4) The amount of feed required per unit of gain will be less.

Promiscuous feeding of pelleted hays to beef cattle can lead nowhere. Pelleted hays for growing slaughter cattle may offer an opportunity for lowering feed cost when the pelleted feeds are used at the proper time in a finite feeding system. The finite feeding system as used here may be thought of as a system of growing calves after weaning with the intent to produce a 1050 pound Choice slaughter steer at an age not greater than 16 months.

Discussion.

9:45 A.M. Break

Topic - Pasture and Forage Utilization

10:00 A.M. Rotation Versus Continuous Grazing in the Humid Southeast -
Roy E. Blaser, Virginia

Higher herbage yields may be almost invariably expected from optimum rotational grazing management as compared with optimum continuous grazing management. The ratio of rest to grazing period under rotational grazing has a decided influence on yields. Yields are generally increased as rest periods are lengthened and the grazing period is shortened. Continuous grazing may be expected to produce lower yields than rotational grazing for two reasons: (1) continuous defoliation may deplete food reserves and (2) it reduces light interception. Both of these factors are important when considering the yield potential. The yield advantage of rotational grazing as compared with continuous grazing must also be associated with the morphological characteristics of a given species. A dwarf prostrate species that is difficult to defoliate will produce comparatively much higher yields than an erect species that is easy to defoliate under continuous grazing. The yield advantages from rotational grazing can be dissipated by grazing too close or not grazing close enough where much herbage is wasted. Plants like alfalfa must be consumed as completely as possible to gain yield advantages as regrowth comes from underground rhizomes. Conversely, close grazing of plants like orchardgrass removes stubble reserves and retards the rate of regrowth.

Cows usually produce as much or more milk under continuous grazing than for rotational grazing. Likewise, beef steers or lambs may be expected to gain as much or more per animal under continuous grazing than for rotational grazing. This is attributed to accumulated feed within the single pasture under continuous grazing which allows for selective grazing. Pastures grazed rotationally are managed so that the grazeable herbage is consumed rather quickly after which the animals are rotated to a fresh pasture. The selective grazing under continuous grazing apparently increases the dry matter intake or the digestibility of the herbage that is consumed. It would appear that both of these factors are generally associated with the high rate of gain under continuous grazing.

In our experiments we have studied the effects of selective grazing by the "top and bottom" grazing method where one group of animals consume the top growth and a second group of animals consume the bottom growth. Top grazers has reference to animals eating the first 50% of grazeable herbage, whereas the bottom grazers consume the remaining 50%. Our experiments at the Northern Virginia Pasture Research Station show that the top grazing method encouraged higher animal output for both beef and dairy cattle. When considering these results, it becomes evident that animal output is associated with selective grazing rather than with continuous or rotational grazing. It would be possible to obtain higher animal output from rotational grazing than from continuous grazing if a high degree of selective grazing was allowed under rotational grazing. It becomes evident that grazing management is a compromise between stocking rate and animal output. High stocking rate with low selective grazing results in low per animal output. Conversely, low stocking rate with high selective grazing results in high animal output but low acre returns. Acre output is a compromise between animal output and stocking rate; hence, a researcher can obtain almost any kind of data depending upon how the experiment is conducted.

It may be concluded that the primary advantages of rotational grazing are higher yields of herbage and livestock commodities per acre, better seasonal distribution of herbage production, better control in botanical composition, and longer survival of species. Rotational grazing cannot produce these advantages unless the natural and imposed environment is favorable for potential high yields.

10:25 A.M. Rotation Versus Continuous Grazing in Semi-Arid Southeast -
Marvin E. Riewe, Angleton, Texas

Because of the interrelationships of the many factors involved in the management of the plant-animal complex, fundamental principles involved in pasture management have been difficult to define. An attempt has been made during the past two years in two grazing studies conducted by the Texas station to understand and more satisfactorily define some of the principles involved.

The first of these studies is being conducted in the Gulf Coast Prairie at Angleton on an improved perennial pasture consisting principally of Dallisgrass and white clover. One management system utilized a stocking rate which the pasture

was expected to carry for the entire grazing season. Any forage produced in excess of the animal requirement remained on the pasture. In another system the stocking rate was regulated during the spring of the year to remove excess forage by grazing animals. In a third system, the pastures were divided into three paddocks with the cattle moved every 14 days. The cattle were grazed alternately on two paddocks during the spring with excess forage removed as hay from the third paddock. For the remainder of the year (summer and fall) the cattle were rotated between the three paddocks. The stocking rate for the whole pasture was the same as for the first management system described above.

A second study is being conducted in the East Texas Timberlands Area at Lufkin. This pasture consists principally of Common Bermudagrass and reseeding winter annual clovers. Two levels of nitrogen fertilization plus high nitrogen fertilization with supplemental irrigation are the agronomic treatments used. A stocking rate variable with each agronomic treatment has been introduced.

In these studies for 1957 and 1958 at Angleton and for 1958 at Lufkin (only one year's data has been obtained from the Lufkin study) stocking rate was negatively correlated with the average daily gain (ADG). Increasing the stocking rate resulted in a decrease in the amount of forage available per animal. By decreasing the amount of forage available per animal, the percentage forage utilization was increased but at the expense of a lowered ADG. The estimated percentage forage utilization was expected consumption (NRC standards) expressed as a per cent of apparent consumption ("cage and mower strip"). This method contains some rather obvious errors but it is felt that in lieu of a better method that it is a tool of some value.

By using the simple regression equation of stocking rate on ADG the relationship of stocking rate to gain per acre can be estimated. This provides a valuable tool in estimating the stocking rate required for maximum liveweight gain per acre even if this stocking rate is not actually attained within the limits of the experiment. Further it provides a basis for an estimate of both ADG and liveweight gain per acre for varying stocking rates on a given pasture.

If animal liveweight gain per acre plus the hay produced from the rotationally grazed pastures in the Angleton study are both considered, rotational grazing was not as good as continuous grazing. If gain per acre for the rotational grazed pasture is corrected for the heavier stocking rate imposed on the two spring grazed paddocks than gain per acre was still not equal to the continuously grazed pastures.

The ADG of the animals was directly related to the amount of forage available per animal at a given time and to the percent crude protein in the available forage. The rotational grazing system used imposed a greater restriction on the forage available per animal than could be accounted for on the basis of stocking rate alone. The change in the protein content of the available forage from the beginning to the end of a two week grazing period was much greater on the rotationally grazed paddocks than was true on the continuously grazed pastures regardless of the stocking rate. Therefore, the average protein content of the forage available to the animals on the rotationally grazed pastures was significantly less than was the case on the continuously grazed pastures. This situation

was further aggravated by a reduction in the percentage clover in the rotationally grazed sward as compared to the continuously grazed sward.

The evidence accumulated to date indicates strongly that cattle must be rotated rapidly to prevent the adverse effect on the animal caused by the poorer quality of forage available to the animal toward the end of the grazing period. Grazing down to a given height is unsatisfactory as a means of determining when cattle should be rotated from one paddock to another. This is true because the quality of the forage remaining at any given height and available to the animal is markedly influenced by the height of the forage when grazing was begun and the length of time the forage has been grazed. Therefore, the only tenable rotation scheme appears to be one in which the cattle are moved rapidly on a set time basis. The rapidity with which cattle are rotated may vary some with season, i. e., cattle may need to be moved more rapidly during the summer when forage quality is lower as compared to cattle grazing higher quality forage in the spring. It becomes obvious, too, that no system of rotational grazing may be profitable on the poorer quality forage commonly found on our perennial pastures during the summer.

Forage yield per acre was lower on the rotational grazed pastures than on the continuously grazed pastures. It is felt that this is the result of the repeated more severe defoliation occurring on the rotationally grazed pastures.

10:50 A.M. Rotation Versus Continuous Grazing From the Dairyman's Viewpoint -
R. E. McCullough, Georgia

A dairyman seldom makes so simple a decision as deciding between two systems of grazing. Grassland farming is a series of decisions dictated by feed available, market, weather and many other factors. The farmer's basic decision is one of maximizing net returns from available resources on an annual basis. The one requirement is a continuous supply of high quality forage with quality being dictated by type of animal. The producing dairy cow and the young dairy calf require top quality forage while the growing heifer and dry cow can benefit from the aftermath of the above forage. To an extent, the dairy heifer may be subjected to "ups and downs" in feed, but all other dairy animals have a constant demand.

Basically a dairyman's decision on the use of a given field of forage is a day to day decision and there is seldom a long-time system found in practice. Each intensity of forage utilization improved the efficiency of forage use and narrows the margin between all-forage and a forage + grain feeding program. Since there are long-time effects in dairy cow nutrition, today's feeding program must be weighed against tomorrow's need production.

At present, in the Southeast, most temporary type pastures are subjected to some form of rotational grazing and permanent forages to continuous grazing. The big move is not from one system to the other but from grazing to stored feeding with emphasis on silage.

Discussion.

11:30 A.M. Business Meeting - Chairman E. C. Holt, Presiding

A new publication, Grassland Progress with Dr. Robert E. Wagner as Editor was announced. It will be a quarterly publication of the American Grassland Council.

A motion by M. S. Offutt, seconded by N. L. Taylor, that the committee report on forage evaluation be approved and that the present committee be continued as a standing committee on forage evaluation was passed.

The nominating committee proposed the name of M. S. Offutt for consideration as the new member of the executive committee. R. E. Blaser moved the nominations be closed, and to instruct the Secretary to cast a unanimous ballot for the slate as proposed. After a second by R. M. Patterson, motion passed unanimously.

Executive Committee Report:

The executive committee transmitted a letter from the Arkansas Experiment Station extending an invitation for the 1960 meetings and recommended the acceptance of this invitation. J. R. Harlan moved acceptance, Julian Craigmiles seconded, and motion passed unanimously. The dates for the 1960 meetings are to be announced by the host institution. It was suggested that the 1960 meetings be held in early June.

Change in method of planning programs:

Instead of the usual meeting on programs at the Southern Agricultural Workers Conference, Chairman Holt suggested that incoming Chairman appoint a program committee charged with the responsibility for developing a program for the various sessions of the next meeting.

Resolutions Committee was asked for a report which was submitted as follows:

Be it resolved that the 16th Annual Southern Pasture and Forage Crop Improvement Conference go on record as expressing thanks to the administration and staff of Mississippi State University for the excellent facilities and fine hospitality, and to express appreciation to the program chairman, and to participants, and to all who contributed to the success of this meeting. Appreciation is expressed also to Dean Clay Lyle, Dr. Hoover, H. D. Bennett, Bill Knight and all of the local staff who worked so hard to accomplish this successful meeting.

Outgoing Chairman, E. C. Holt introduced the new Chairman, Dr. N. L. Taylor. Chairman Taylor appointed a program committee composed of N. L. Taylor, Chairman, P. G. Woolfolk, Kentucky, P. B. Gibson, South Carolina, S. H. West, Florida and J. H. Halpin, Clemson. There being no further business at hand, the meeting adjourned.

12:00 Noon Adjourn.

REGISTRATION LIST - 1959

<u>Name</u>	<u>Address</u>	<u>Affiliation</u>
<u>Alabama</u>		
Ansley, Bill	Auburn	Ala. Polytechnic Institute
Anthony, W. B.	"	Ala. Agricultural Exp. Station
Bennett, O. L.	Thorsby	Soil & Water Conservation
Donnelly, E. D.	Auburn	Ala. Agricultural Exp. Station
Ensminger, L. E.	"	" " " "
Evans, E. M.	"	" " " "
Hawkins, G. E.	"	" " " "
Holt, M. E.	Birmingham	Soil Conservation Service
Hoveland, C. S.	Auburn	Ala. Agricultural Exp. Station
Johnson, W. C.	"	" " " "
Patterson, R. M.	"	" " " "
<u>Arkansas</u>		
Byrd, Morris	Little Rock	Soil Conservation Service
Offutt, M. S.	Fayetteville	Ark. Agricultural Exp. Station
Spooner, A. E.	"	" " " "
<u>D. C.</u>		
Ely, R. E.	Washington	U. S. Department of Agriculture
Paltridge, T. B.	Washington	Australian Embassy
Ronningen, T. S.	Washington	U. S. Department of Agriculture
<u>Florida</u>		
Hentges, Jr., J. F.	Gainesville	Fla. Agricultural Exp. Station
Hutton, C. E.	Jay	West Fla. Experiment Station
Jones, D. W.	Ft. Myers	Fla. Agricultural Exp. Station
Killinger, G. B.	Gainesville	Fla. Agricultural Exp. Station
Linden, D. B.	"	" " " "
Prine, G. M.	"	" " " "
Ruelke, O. C.	"	" " " "
Wallace, R. W.	Quincy	No. Florida Experiment Station
West, S. H.	Gainesville	Fla. Agricultural Exp. Station
<u>Georgia</u>		
Adams, W. E.	Athens	Ga. Agricultural Exp. Station
Beaty, E. R.	"	" " " "
Brooks, O. L.	Midville	S. E. Ga. Branch Exp. Station
Burns, R. E.	Experiment	Ga. Agricultural Exp. Station
Burton, G. W.	Tifton	Coastal Plain Exp. Station
Craigsmiles, J. P.	Experiment	Ga. Agricultural Exp. Station
Elrod, J. M.	"	" " " "
Forbes, Ian	Tifton	Coastal Plain Exp. Station

<u>Name</u>	<u>Address</u>	<u>Affiliation</u>
<u>Georgia (Continued)</u>		
Jackson, J. E.	Tifton	Coastal Plain Exp. Station
Langford, W. R.	Experiment	Regional Plant Introd. Station
McCreery, R. A.	Athens	Ga. Agricultural Exp. Station
McCullough, M. E.	Experiment	Ga. Agricultural Exp. Station
Marchant, W. H.	Tifton	Coastal Plain Exp. Station
Newton, J. P.	Experiment	Ga. Agricultural Exp. Station
Powell, J. D.	Americus	Americus Nursery Br. Station
Reed, J. F.	Atlanta	American Potash Institute
Rogers, T. H.	Athens	Ga. Agricultural Exp. Station
Tisdale, S. L.	Atlanta	National Plant Food Institute
Young, W. C.	Athens	Soil Conservation Service
<u>Kentucky</u>		
Fergus, E. N.	Lexington	Kentucky Agricultural Exp. Sta.
Grainger, R. B.	"	" " " "
Stroube, W. H.	"	" " " "
Taylor, N. L.	"	" " " "
Taylor, T. H.	"	" " " "
Thompson, Warren	"	" " " "
Woolfolk, P. G.	"	" " " "
<u>Louisiana</u>		
Curtis, O. D.	Franklinton	S. E. La. Dairy & Livestock Sta.
Hindery, G. A.	Baton Rouge	La. Agricultural Exp. Station
Owen, C. R.	" "	" " " "
<u>Maryland</u>		
Alexander, C. W.	Beltsville	U. S. Department of Agriculture
Hanson, A. A.	"	" " "
Hein, M. A.	"	" " "
Henson, P. R.	"	" " "
Hollowell, E. A.	"	" " "
McCloud, D. E.	"	" " "
Moore, Lane	"	" " "
<u>Mississippi</u>		
Andrews, W. B.	Yazoo City	Mississippi Chemical Corp.
Bailey, Earl	Starkville	American Potash Institute
Barrentine, B. F.	State College	Miss. Agricultural Exper. Sta.
Bennett, H. W.	" "	" " " "
Blount, C. L.	Poplarville	So. Mississippi Br. Exp. Station
Coats, R. E.	Raymond	Brown Loam Station

<u>Name</u>	<u>Address</u>	<u>Affiliation</u>
<u>Mississippi (Continued)</u>		
Diggs, Bill	State College	Miss. Agricultural Exp. Sta.
Johnson, C. M.	" "	" " " "
Jones, T. N.	" "	" " " "
Knight, W. E.	" "	" " " "
Lindley, C. E.	" "	" " " "
Lyle, Clay	" "	" " " "
Miles, J. T.	" "	" " " "
Morrison, E. G.	Raymond	Brown Loam Experiment Sta.
Ramsey, D. S.	State College	Miss. Agricultural Exp. Sta.
Rutledge, G. C.	" "	" " " "
Williams, Carl	" "	" " " "

North Carolina

Blake, C. T.	Raleigh	N. C. Agricultural Exp. Sta.
Carter, M. W.	" "	" " " "
Chamblee, D. S.	" "	" " " "
Cope, W. A.	" "	" " " "
Gilbert, W. B.	" "	" " " "
Smart, W. W. G.	" "	" " " "
Thomas, W. E.	" "	" " " "
Woodhouse, W. W.	" "	" " " "

Oklahoma

Chessmore, R. A.	Ardmore	Samuel Roberts Noble Found.
Elder, W. C.	Stillwater	Oklahoma Agric. Exp. Sta.
Harlan, J. R.	" "	" " " "
Huffine, W. W.	" "	" " " "

Oregon

Poulton, C. E.	Corvallis	Ore. Agricultural Exp. Sta.
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South Carolina

Beinhart, E. D.	Clemson	S. C. Agric. Exp. Station
Gibson, P. B.	" "	" " " "
Halpin, J. E.	" "	" " " "
McClain, E. F.	" "	" " " "
Maurer, T. C.	Spartanburg	Soil Conservation Service

<u>Name</u>	<u>Address</u>	<u>Affiliation</u>
<u>Tennessee</u>		
Burns, J. D.	Knoxville	Tenn. Agric. Exp. Station
Chandler, E. K.	"	National Plant Food Inst.
Fribourg, H. A.	"	Tenn. Agric. Exp. Station
Turner, Jim	"	Pacific Coast Borax
<u>Texas</u>		
Ball, C. E.	Dallas	Farm Journal
Bashaw, E. C.	College Station	Texas Agric. Exp. Station
Holt, E. C.	" "	" " " "
Lewis, R. D.	" "	" " " "
Staten, R. D.	" "	" " " "
Weihing, R. M.	Beaumont	U. S. Department of Agric.
<u>Virginia</u>		
Blaser, R. E.	Blacksburg	Va. Agricultural Exp. Sta.
Engel, R. W.	"	" " " "
Fontenot, J. P.	"	" " " "
Hardison, W. A.	"	" " " "
Shoulders, J. F.	"	" " " "
Taylor, L. H.	"	" " " "
Ward, C. Y.	"	" " " "
<u>Foreign (Puerto Rico)</u>		
Brenes, Luis Rivera	Rio Piedras	P. R. Agric. Exp. Station
Fortuno, J. Velez	" "	" " " "

Total Attendance: 116